The role of rubber agroforestry in farming systems and its effect on households: Adaptation strategies to climate change risks?

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Extended abstract

Introduction

Expectations from rubber agroforestry systems (RAS) are multiple:

1. Income diversification (rubber + fruits + timber, etc.) provide better economic resilience and also economic sustainability,
2. No impact of agroforestry practices on rubber production (kg tree^{-1}year^{-1}) as long as no trees are above rubber canopy; rubber production is generally not in competition with associated crops,
3. Less soil erosion and better use of water as vegetal biodiversity increases 'forest-like behaviour',
4. Soil fertility maintenance or improvement if soil is covered by grasses and shrubs,
5. Possibility of timber production as rubber farmers might be the very next timber producers as timber can be easily cropped with rubber (up to 50 trees per hectare),
6. Rubber trees do not require high quantities of fertilizers during mature period and almost no pesticides. Rubber is already 'bio-compatible'
7. Reservoir of local biodiversity and 'forest effect' on climate in large areas; environmental impact and positive effect on climate change; potential mitigation but still to be assessed,
8. RAS are more globally environmental friendly where re-internalizing externalities is a real challenge, including impacts of climatic change,
9. Negative effect of high temperatures on physiology of rubber trees and NR production: agroforestry may play a positive role to maintain good climatic conditions and so rubber production

In Indonesia, the Smallholder Rubber Agroforestry Project (SRAP) monitored RAS trials from 1994 to 2007 (Figure 1) with three main RAS systems all based on clonal planting material: RAS1 with secondary forest regrowth (no intercropping during immature period), Figure 2, RAS2 with fruits and timber associated trees (and intercropping during immature period), Figure 3 and RAS3 similar to RAS2 but with fast growing trees and selected cover crops for shading and killing *Imperata cylindrica* (no intercropping), Figure 4.

In Thailand, many RAS systems are developed either for intercropping during immature periods or during mature periods with fruit (durian, rambutan, longkong, etc.), vegetables (pak liang/*Gnetum*) and timber associated trees (teak, mahogany, etc.).

Impact of oil palm development

In Indonesia, oil palm is now the very first crop for local farmers and estates, even if rubber remains important for local farmers

Rubber Agroforestry Systems (RAS)
= diversification inside one cropping system

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Rubber planting density similar to that of monoculture

RAS 1	RAS 2	RAS 3
An improved extensive jungle rubber	An intensive system with intercrops	Rehabilition of *Imperata* grasslands

Figure 1. RAS systems (SRAP project 1994/2007)

Figure 2. RAS 1, Sanggau/West Kalimantan, 2019

Figure 3. RAS 2 in Kopar/West Kalimantan/Sanggau, 2007.

Figure 4. RAS 3 in transmigration area, Ttimulia/West Kalimantan, 2007

who want to maintain a certain level of crop diversification. A large part of the local jungle rubber area (that covered 90% of the rubber area in 1994) has been converted to oil palm and/or clonal rubber plantation in 2020. Now, most farmers cultivate in average 2 ha of oil palm, 2 ha of rubber (partly clonal and sometimes remaining jungle rubber) and a small area for food crops or other crops. These farmers cannot count on land availability anymore as they did some 25 years ago.

The lessons learned

RAS trials in Indonesia came right in time in 1994 with a strong demand from farmers for low cost clonal systems with income diversification: the right time at the right place but oil palm came in 1997 with a very strong pressure from companies (through the policy of concessions) providing an interesting alternative to rubber with full credit (but loss of land) and better return on labour. Interest in agroforestry practices remains high for older farmers but is limited in younger generations. What will be the future of RAS? It is time for rubber replantation (conversion of old jungle rubber to clonal plantation) and the same old story remains: poor access to planting materials, know-how for grafting, cost reductions, and a serious need for training and good technical information on tapping practices. The poor tapping practices in Indonesia limit rubber lifespan to less than 25 years. We also observed a serious impact of root diseases in areas with forest or old jungle rubber before plantation. It is estimated that up to 25% of clonal plantation may be RAS in 2020. RAS remains a cropping system with relatively high biodiversity (Figures 4 and 5).

In Thailand, largely due to the rubber replanting program implemented since the 1960s that promoted clonal rubber monoculture, agroforestry practices during the mature period are very limited. So far, Thai farmers have preferred diversification at the farm and household levels rather than at the plot level. Low rubber prices do not help to maintain interest in rubber but obviously raise interest for agroforestry practices. The Thai government has also started to ease the restrictions for RAS.

Conclusion

The question remains: what is the possible impact of agroforestry on climate change adaptation and mitigation? Globally, more trees and more biomass will create a more local humid and probably less hot microclimate at plot level that would be more efficient to adapt to climate change and would limit the decrease in latex production induced by higher temperatures. It is expected and probable, but still has to be measured and verified.

Some trade-offs might arise: i) there may be some competition for water between rubber trees and associated trees or crops, particularly in some areas like north-eastern Thailand for instance, and possibly South Sumatra and Cambodia outside 'red soils' or similar situations, ii) for shade, all associated trees should be below rubber canopy, iii) we may observe the development of some diseases due to moisture (*Phytophtora*) as observed in Jambi in 2005 in RAS 1 systems and iv) eventually, some possible allelopathy between trees require carefully designing tree/tree associations.

In terms of research, we suggest designing RAS adapted to local markets, exploring the intercropping possibilities during immature period linked with the local context and constraints to generate income at a critical period for the farmers. For long-term RAS, it is also necessary to identify the cash crop or timber species adapted to farmers' strategies with various types of rubber density: double spacing might be economically interesting for smallholders based on their strategy. For institution and development agencies: most farmers are capable to implement RAS but might lack knowledge and initial capital and access to cash crop/timber plants (if poor availability). National regulation should recognize the right of the farmers to sell timber and any forest product (tree tenure policy is unfavourable in Ivory Coast, for instance).

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